EXHIBIT D

MATERIAL SAFETY DATA SHEET
(MSDS)

Material Safety Data Sheet

Lethal Nerve Agent (GB)

Date: 22 September 1988
Revised: 29 September 1999

In the event of an emergency
Telephone the SBCCOM Operations
Center's 24-hour emergency
Number: 410-436-2148

Section I - General Information

Manufacturer's Address:
U.S. Army Soldier and Biological Chemical Command (SBCCOM)
Edgewood Chemical Biological Center (ECBC)
ATTN: AMSSB-RCB-RS
Aberdeen Proving Ground, MD 21010-5424

CAS Registry Numbers:
107-44-8, 50642-23-4

Chemical Name:
Isopropyl methylphosphonofluoridate

Alternate Chemical Names:
O-Isopropyl Methylphosphonofluoridate
Phosphonofluoridic acid, methyl-, isopropyl ester
Phosphonofluoridic acid, methyl-, 1-methylethyl ester

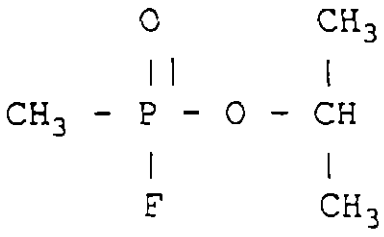
Trade Name And Synonyms:
Isopropyl ester of methylphosphonofluoridic acid
Methylisopropoxyfluorophosphine oxide
Isopropyl Methylfluorophosphonate
O-Isopropyl Methylisopropoxfluorophosphine oxide
Methylfluorophosphonic acid, isopropyl ester
Isopropoxymethylphosphonyl fluoride
Isopropyl methylfluorophosphate
Isopropoxymethylphosphoryl fluoride
GB
Sarin
Zarin

Chemical Family:

Fluorinated organophosphorous compound

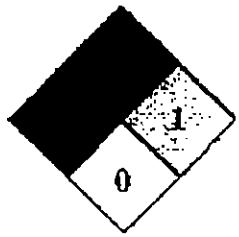
Formula/Chemical Structure:

$C_4 H_{10} F O_2 P$



NFPA 704 Signal:

Health - 4
Flammability - 1
Reactivity - 1
Special - 0



Section II - Ingredients

Ingredients/Name: GB

Percentage by Weight: 100%

Threshold Limit Value (TLV): 0.0001 mg/m^3

Section III - Physical Data

Boiling Point @ 760 mm Hg: 316 °F (158 °C)

Vapor Pressure (mm Hg): 2.9 @ 25 °C

Vapor Density (Air = 1 STP): 4.83 @ 25 °C

Solubility: Miscible with water. Soluble in all organic solvents.

Specific Gravity (H_20=1g/mL): 1.0919 @ 25 °C

Freezing/Melting Point (°C): -56 °C

Liquid Density (g/cc): 1.0887 @ 25 °C
1.102 @ 20 °C

Volatility (mg/m^3): 22,000 @ 25 °C

Viscosity (CENTISTOKES): 1.283 @ 25 °C

Appearance and Odor: Colorless liquid. Odorless in pure form.

Section IV - Fire and Explosion Data

Flashpoint: Did not flash to 280 &degF (McCutchan - Young)

Flammability Limits (% By Volume): Not Applicable

Lower Explosive Limit: Not Applicable

Upper Explosive Limit: Not Applicable

Extinguishing Media: Water mist, fog, foam, CO_2. Avoid using extinguishing methods that will cause splashing or spreading of the GB.

Special Fire Fighting Procedures: GB will react with steam or water to produce toxic and corrosive vapors. All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving GB should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing GB, fire fighting personnel should wear full firefighter protective clothing during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full face piece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes they will wear appropriate levels of protective clothing (See Section VIII).

Do not breathe fumes. Skin contact with nerve agents must be avoided at all times. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminate other areas or sewers. Contact with liquid GB or vapors can be fatal.

Unusual Fire And Explosion Hazards: Hydrogen may be present.

Section V - Health Hazard Data

Airborne Exposure Limits (AEL): The permissible airborne exposure concentration for GB for an 8-hour workday of a 40-hour work week is an 8-hour time weighted average (TWA) of 0.0001 mg/m^3. This value can be found in "DA Pam 40-8,Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX." To date, however, the Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure concentration for GB.

GB is not listed by the International Agency for Research on Cancer (IARC), American Conference of Governmental Industrial Hygienists (ACGIH), Occupational Safety and Health Administration (OSHA), or National Toxicology Program (NTP) as a carcinogen.

Effects Of Overexposure: GB is a lethal cholinesterase inhibitor.

Doses which are potentially life-threatening may be only slightly larger than those producing least effects.

Route	*Form*	*Effect*	*Type*	*Dosage*
ocular	vapor	miosis	ECt50	<2 mg-min/m^3
Inhalation	vapor	runny nose	ECt50	<2 mg-min/m^3
Inhalation (15 l/min)	vapor	severe incapacitation	ICt50	35 mg-min/m^3
Inhalation (15 l/min)	vapor	death	LCt50	70 mg-min/m^3
Percutaneous	liquid	death	LD50	1700 mg/70 kg man

Effective dosages for vapor are estimated for exposure durations of 2-10 minutes.

Symptoms of overexposure may occur within minutes or hours, depending upon the dose. They include: miosis (constriction of pupils) and visual effects, headaches and pressure sensation, runny nose and nasal congestion, salivation, tightness in the chest, nausea, vomiting, giddiness, anxiety, difficulty in thinking, difficulty sleeping, nightmares, muscle twitches, tremors, weakness, abdominal cramps, diarrhea, involuntary urination and defecation. With severe exposure symptoms progress to convulsions and respiratory failure.

Emergency And First Aid Procedures:

Inhalation: Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction, in coordination, etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by a physician). Injections using the Mark I kit injectors may be repeated at 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention **Immediately**.

Eye Contact: Immediately flush eyes with water for 10-15 minutes, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken **Immediately** to a medical treatment facility for observation.

Skin Contact: Don respiratory protective mask and remove

contaminated clothing. **Immediately** wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove excess decontaminant. Administer nerve agent antidote kit, Mark I, only if local sweating and muscular twitching symptoms are observed. Seek medical attention **Immediately.**

Ingestion: Do not induce vomiting. First symptoms are likely to be gastrointestinal. **Immediately** administer Nerve Agent Antidote Kit, Mark I. Seek medical attention **Immediately.**

Section VI - Reactivity Data

Stability: Stable when pure. Plant grade material stablized with tri-n-butylamine can be stored in steel containers for long periods of time at temperatures up to 70 °C, but unstablized material tends to build-up pressure within a few weeks.

Incompatibility: Attacks tin, magnesium, cadmium plated steel, and some aluminum. Slightly attacks copper, brass, and lead; practically no attack on 1020 steels, Inconel and K-monel.

Hazardous Decomposition Products: Hydrolyzes to form HF under acid conditions and isopropyl alcohol and polymers under basic conditions.

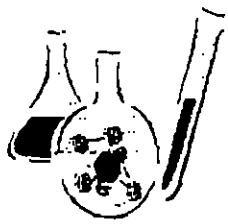
Hazardous Polymerization: Does not occur.

Section VII - Spill, Leak, and Disposal Procedures

Steps To Be Taken In Case Material Is Released Or Spilled: If leaks or spills of GB occur, only personnel in full protective clothing will remain in the area (See Section VIII). In case of personnel contamination see Section V for emergency and first aid instructions.

Recommended Field Procedures: Spills must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, and paper, or cloth towels. Decontaminate with copious amounts of aqueous sodium hydroxide solution (a minimum 10 wt.%). Scoop up all material and place in a DOT approved container. Cover the contents with decontaminating solution as above. After sealing, the exterior will be decontaminated and labeled according to EPA and DOT regulations. All leaking containers will be over packed with sorbent (e.g., vermiculite) placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of decontaminate according to Federal, state, and local laws. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (See Sections II and VIII).

If 10 wt.% aqueous sodium hydroxide is not available then the following decontaminants may be used instead and are listed in the order of preference: Decontaminating Agent (DS2), Sodium Carbonate, and Supertropical Bleach Slurry (STB).



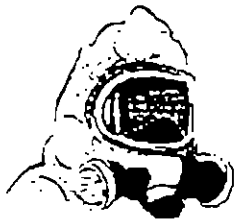
Recommended Laboratory Procedures: A minimum of 56 grams of decon solution is required for each gram of GB. Decontaminant and agent solution is allowed to agitate for a minimum of one hour. Agitation is not necessary following the first hour. At the end of one hour, the resulting solution should be adjusted to a pH greater than 11.5. If the pH is below 11.5, NaOH should be added until a pH above 11.5 can be maintained for 60 minutes. An alternate solution for the decontamination of GB is 10 wt.% sodium carbonate in place of the 10% sodium hydroxide solution above. Continue with 56 grams of decon for each gram of agent. Agitate for one hour but allow three hours for the reaction. The final pH should be adjusted to above zero. It is also permitted to substitute 5.25% sodium hypochlorite or 25 wt.% Monoethylamine (MEA) for the 10% sodium hydroxide solution above. MEA must be completely dissolved in water before addition of the agent. Continue with 56 grams of decon for each gram of GB and provide agitation for one hour. Continue with same ratios and time stipulations. Scoop up all material and clothing. Place all material in a DOT approved container. Cover the contents with decontaminating solution as above. After sealing, decontaminate the exterior of the container and label according to EPA and DOT regulations. All leaking containers will be over packed with sorbent placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of decontaminate according to Federal, State, and local laws. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (See Sections II and VIII).

Waste Disposal Method: Open pit burning or burying of GB or items containing or contaminated with GB in any quantity is prohibited. The detoxified GB (using procedures above) can be thermally destroyed by incineration in EPA approved incinerators according to appropriate provisions of Federal, state and local Resource Conservation and Recovery Act (RCRA) Regulations.

Note: Some decontaminate solutions are hazardous waste according to RCRA regulations and must be disposed of according to those regulations.

Section VIII - Special Protection Information

Respiratory Protection:

Concentration	Respiratory Protective Equipment
< 0.0001 mg/m^3	A full face piece, chemical canister, air-purifying protective mask will be on hand for escape. M40-series masks are acceptable for this purpose. Other masks certified as equivalent may be used. 
>0.0001 or = 0.2 mg/m^3	A NIOSH/MSHA approved pressure demand full face piece SCBA or supplied air respirators with escape air cylinder may be used. Alternatively, a full face piece, chemical canister air-purifying protective mask is acceptable for this purpose (See DA Pam 385-61 for determination of appropriate level)
>0.2 mg/m^3 or unknown	NIOSH/MSHA approved pressure demand full face piece SCBA suitable for use in high agent concentrations with protective ensemble (See DA Pam 385-61 for examples).

Ventilation:

Local exhaust: Mandatory. Must be filtered or scrubbed to limit exit concentrations to < 0.0001 mg/m^3. Air emissions will meet local, state, and federal regulations.

Special: Chemical laboratory hoods will have an average inward face velocity of 100 linear feet per minute (lfpm) ±20% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods will have an inward face velocity of 150 lfpm ±20%. Laboratory hoods will be located such that cross-drafts do not exceed 20% of the inward face velocity. A visual performance test using smoke-producing devices will be performed in assessing the ability of the hood to contain agent GB.

Other: Recirculation or exhaust air from chemical areas is prohibited. No connection between chemical areas and other areas through ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested at least semiannually or after

modification or maintenance operations. Operations should be performed 20 centimeters inside hood face.

Protective Gloves: Butyl Rubber Glove M3 and M4 Norton, Chemical Protective Glove Set

Eye Protection: At a minimum chemical goggles will be worn. For splash hazards use goggles and face shield.

Other Protective Equipment: For laboratory operations, wear lab coats, gloves, and have mask readily accessible. In addition, daily clean smocks, foot covers, and head covers will be required when handling contaminated lab animals.

Monitoring: Available monitoring equipment for agent GB is the M8/M9 detector paper, detector ticket, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAAMS), Automated Continuous Air Monitoring System (ACAMS), Real-Time Monitor (RTM), Demilitarization Chemical Agent Concentrator (DCAC), M8/M43, M8A1/M43A1, CAM-M1, Hydrogen Flame Photometric Emission Detector (HYFED), the Miniature Chemical Agent Monitor (MINICAM), and the Real Time Analytical Platform (RTAP).

Real-time, low-level monitors (with alarm) are required for GB operations. In their absence, an Immediately Dangerous to Life and Health (IDLH) atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

Section IX - Special Precautions

Precautions To Be Taken In Handling And Storing: When handling agents, the buddy system will be incorporated. No smoking, eating, or drinking in areas containing agents is permitted. Containers should be periodically inspected for leaks, (either visually or using a detector kit). Stringent control over all personnel practices must be exercised. Decontaminating equipment will be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and shower thoroughly with special attention given to hair, face, neck, and hands using plenty of soap and water before leaving at the end of the work day.

Other Precautions: Agent containers will be stored in a single containment system within a laboratory hood or in a double containment system.

For additional information see "AR 385-61, The Army Toxic Chemical Agent Safety Program," "DA Pam 385-61, Toxic Chemical Agent Safety Standards," and "DA Pam 40-173, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX."

Section X - Transportation Data

Note: Forbidden for transport other than via military (Technical

Escort Unit) transport according to 49 CFR 172

Proper Shipping Name: Toxic liquids, organic, n.o.s.

DOT Hazard Class: 6.1, Packing Group I, Hazard Zone A

DOT Label: Poison

DOT Marking: Toxic liquids, organic, n.o.s. (Isopropyl methylphosphonofluoridate) UN 2810, Inhalation Hazard

DOT Placard: Poison

Emergency Accident Precautions And Procedures: See Sections IV, VII, and VIII.

Precautions To Be Taken In Transportation: Motor vehicles will be placarded regardless of quantity. Drivers will be given full information regarding shipment and conditions in case of an emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipment of agents will be escorted in accordance with AR 740-32.

This page last updated on 28 September 1999